VHG™

Mass Calibration in ICP-MS


Image by SPECTRO

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Our Quality: ISO 17043 | ISO 17034 | ISO/IEC 17025 | ISO 9001

LGC

Introduction

ICP-MS is a powerful analytical technique that relies on the direct measurement of analyte ions. The mass of typical elemental ions ranges from Li^+ at 6 and 7 atomic mass units (amu) to U^+ at masses 234, 235 and 238. When configured correctly modern ICP-MS instruments yield detection limits of less than 1 ppt for most elements.

What is Mass Calibration?

Small variations in electronic components result in every ICP-MS having a unique correlation between quadrupole operating parameters (e.g. RF and DC voltage) and ion transmission. Mass calibration is the critical process whereby the correlation between quadrupole voltages and ion transmission is established and stored in the instrument's software for use during subsequent analytical measurements. It is the process used to "teach" the instrument exactly what voltages correspond to the transmission of each mass.

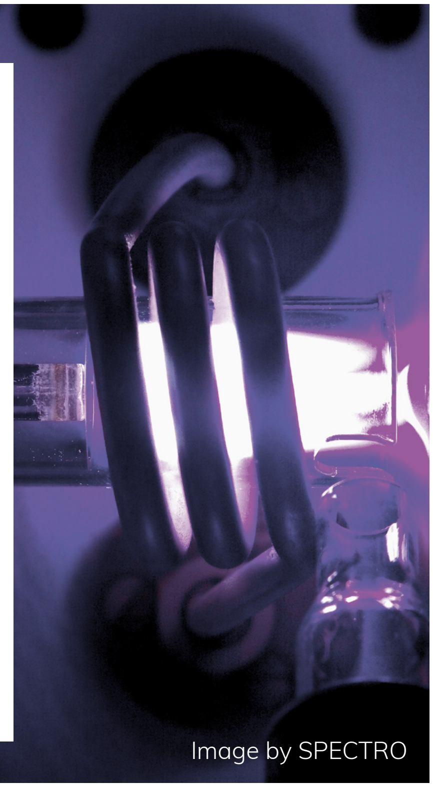


Image by SPECTRO

Why is Mass Calibration Important?

The mass calibration process helps to ensure the instrument measures each analyte ion at the correct location in the spectrum. Mass calibration is part of the instrument tuning process, which also includes optimizing resolution and peak shape thereby minimizing interferences from adjacent masses. Below we will see how mass calibration affects sensitivity (detection limits), stability (RSDs) and susceptibility to interferences.

Figure 1 is a partial ICP-MS spectrum, in this case covering the region between 20 to 29 amu. The vertical red line in the middle of the $^{28}Si^+$ peak indicates where the instrument expects the center of the peak to be located following mass calibration. During routine quantitative analysis ICP-MS instruments usually collect intensity data in "peak jumping" mode where each analyte ion is measured at a single point on its spectral peak; the vertical red line in this example. When the measurment position is well centered the signal intensity will be at its maximum contributing to lower detection limits. Further, any slight electronic drift that may cause small mass shifts will have minimal impact on signal stability contributing to more favorable measurement precision (lower RSDs).

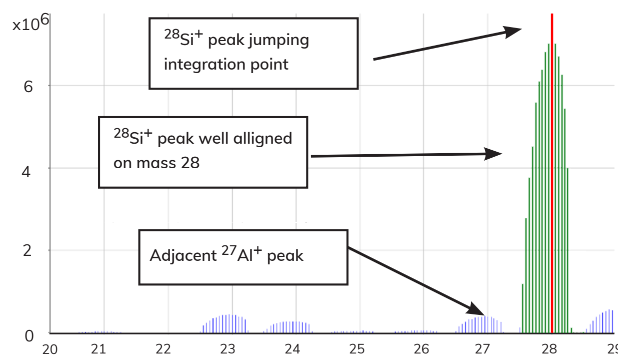


Figure 1. ICP Mass Spectrum: 20 → 29 amu; Accurate mass calibration

Consider for a moment the impact of inaccurate mass calibration. For example, what if your instrument was attempting to measure $^{28}Si^+$ at the peak position highlighted by the red line shown in **Figure 2.** In this case, the signal intensity would be degraded by about 20% which would negatively impact instrument detection limits.

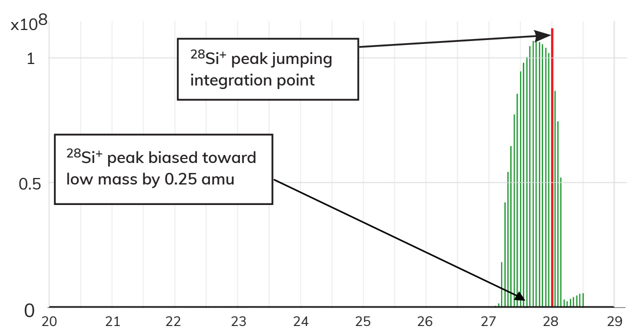


Figure 2. ICP Mass Spectrum: 20 → 29 amu; Poor mass calibration

Perhaps more important are the impacts even minor shifts in peak position would have on measurement precision and spectral interferences. An example of how mass calibration can impact spectral interferences is shown in **Figure 3**. In this view, one can see the contribution at mass 27 from the low mass "tail" of the $^{28}Si^{+}$ peak. With this mass calibration, a sample containing high concentrations of Si would yield a significant interference on monoisotopic aluminum at mass 27. Regulated methods, such as EPA Method 200.8, incorporate very specific requirements for mass calibration that are intended to help protect the analyst from the consequences of inadequate mass calibration.

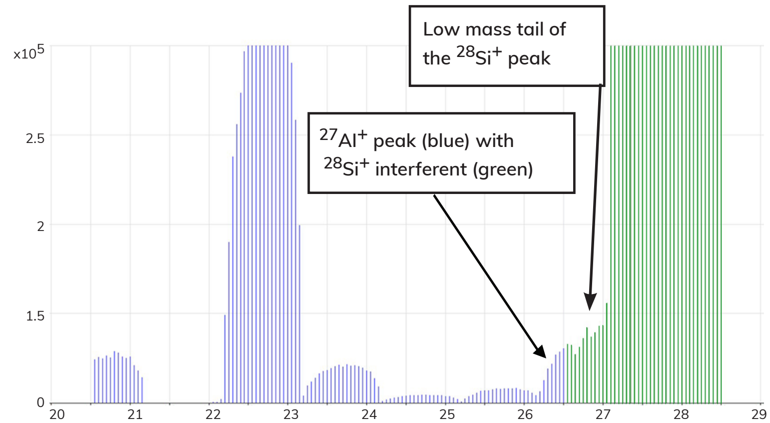


Figure 3. ICP Mass Spectrum: 20 → 29 amu; Poor mass calibration

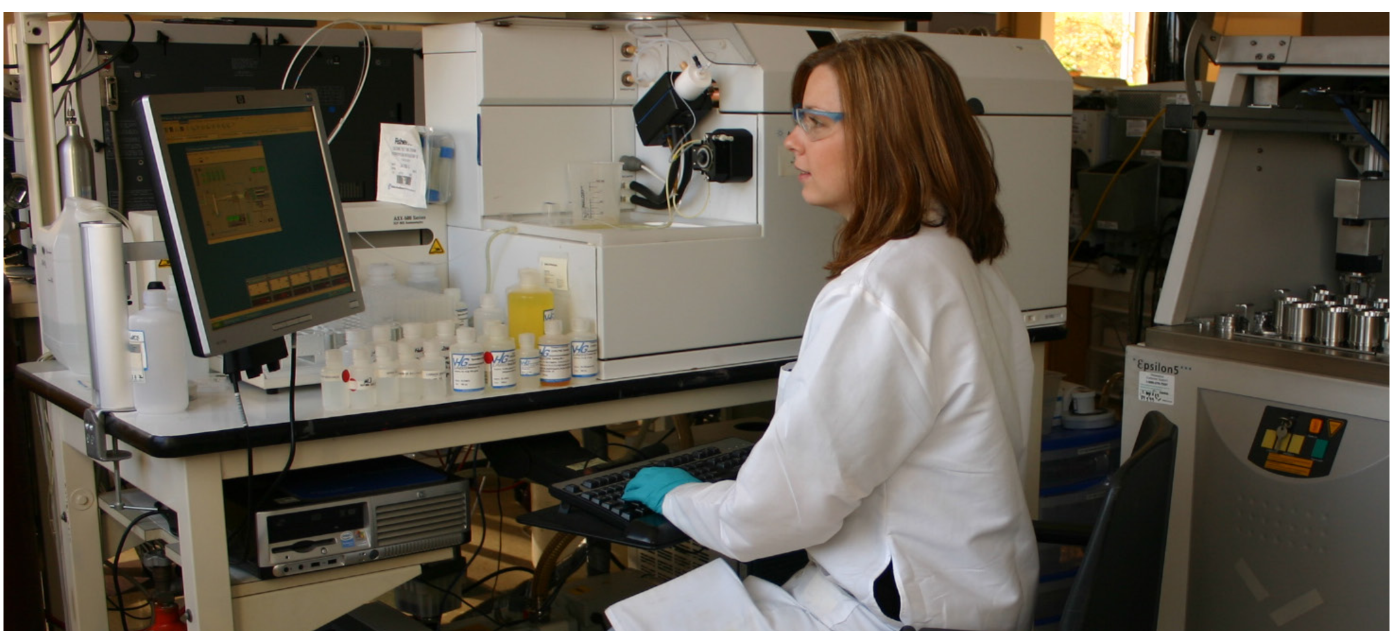
EPA Method 200.8 rev 5.4

Section 12, Quality Control: If the mass calibration is not within 0.1 amu over the range of 6 to 210 amu... the analysis shall be terminated, the problem corrected, and the instrument re-tuned.

How Mass Calibration is Performed

All modern ICP-MS instruments incorporate an automated mass calibration routine. The instrument operator simply loads the tuning or mass calibration solution designed for use with their model of instrument, and the system software does the rest.

VHG™, an LGC Company, manufactures a complete line of mass calibration, wavelength calibration & tuning solutions for most commercially available ICP/ICP-MS instruments. Most are listed in the table on the following page, but for a full list of ICP-OES and ICP-MS Start Up Solutions, visit www2.lgcgroup.com/VHG_StartUpSolutions.



Mass Calibration and Tuning Solutions

Tuning and Mass Calibration Solutions for ICP-MS				
Description	Composition	Product No.	mL	Suitable for use with
Tuning / Mass Calibration Multi-Element Mix 1 *(concentrate)*	^{7}Li, Y, Ce, Tl @ 10 µg/mL in 5% HNO_3	VHG-LMSTNG1-500	500	All models
Tuning / Mass Calibration Multi-Element Mix 1A *(concentrate)*	^{7}Li, Co, Y, Ce, Tl @ 10 µg/mL in 1% HNO_3, 0.5% HCl	VHG-LMSTNG5CONC-500	500	All models
Tuning / Mass Calibration Multi-Element Mix 2 *(concentrate)*	Be, Mg, Co, In, Ce, Pb @ 10 µg/mL in 1% HNO_3	VHG-LMSTNG2Z-500	500	All models
Tuning / Mass Calibration Multi-Element Mix 3 *(concentrate)*	^{7}Li, Be, Mg, Co, Y, In, Ba, Ce, Tb, Pb, U @ 10 µg/mL in 5% HNO_3	VHG-LMSTNG3Z-500	500	All models
Tuning Solution *(see composition)*	Ce, Co, Li, Tl, Y @ 10 µg/mL in 2% HNO_3	VHG-LAGTSTK1-100	100	Agilent® ICP-MS: 7500, 7700, 7800, 7900, 8800, 8900
Tuning Solution 2	Ce, Co, Li, Mg, Tl, Y @ 10 µg/mL in 2% HNO_3	VHG-LAGTSTK2-100	100	Agilent® ICP-MS: 7500, 7700, 7800, 7900, 8800, 8900
Tuning Solution *(see composition)*	Ce, Co, Li, Mg, Tl, Y @ 1 µg/L in 2% HNO_3	VHG-LMSTNG101-500	500	Agilent® ICP-MS: 7500, 7700, 7800, 7900, 8800, 8900
Tuning Solution *(see composition)*	^{7}Li, Co, Y, Ce, Tl @ 10 µg/L in 2% HNO_3	VHG-LMSTNG5DIL-500	500	Agilent® ICP-MS: Various Models
Tuning Solution *(see composition)*	Be, Mg, Fe, Co, In, Ce, Pb, Th, U @ 1 µg/L; Ba @ 10 µg/L in 2% HNO_3	VHG-LMSTNG8-500	500	PerkinElmer ® ICP-MS: DRC, DRCII
Setup / Stability / Masscal Solution	Ba @ 10 µg/L; Al, Cd, Ce, Cr, Cu, In, Mg, Mn, Pb, Rh, Th @ 1 µg/L in 0.5% HCl	VHG-LPEMCAL-500	500	PerkinElmer® ICP-MS: E6100DRC, DRCII
Setup Solution *(see composition)*	Be, Ce, Fe, In, Li, Mg, Pb, U @ 1 µg/L in 1% HNO_3	VHG-LPENXSUSDIL-500	500	PerkinElmer® ICP-MS: NexION™
KED Setup Solution	Co @ 10 µg/L; Ce @ 1 µg/L in 1% HNO_3	VHG-LPENXKED-SUS-250	250	PerkinElmer® ICP-MS: NexION™
Setup Solution *(see composition)*	Be, Ce, Fe, In, Li, Mg, Pb, U @ 10 µg/L in 1% HNO_3	VHG-LPENXSUS-500	500	PerkinElmer® Instruments: NexION™
Tuning Solution 1	Ba, Be, Ce, Co, In, Li, Mg, Pb, Rh, Tl, U, Y @ 10 µg/mL in 2% HNO_3, 5% HCl	VHG-LPETSOL1-100	100	PerkinElmer® ICP-MS: DRC, DRCII, NexION™
Tuning Solution *(see composition)*	^{7}Li, Be, Mg, Co, In, Ba, Ce, Pb, Bi, U @10 ug/L in 2% HNO_3	VHG-LMSTNG6-100	100	Thermo Scientific™ ICP-MS: X-Series
Tuning Solution *(see composition)*	Be, Mg, Co, In, Ba, Ce, Tl, Pb, Th @ 250 µg/L in 2% HNO_3	VHG-LMSTNG9-500	500	Varian® ICP-MS: Various models

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